TAR-SAND RESOURCES OF THE UINTA BASIN, UTAH

A CATALOG OF DEPOSITS

compiled by
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Prepared for:
State of Utah
Department of Community and Economic Development
Permanent Community Impact Board

Prepared by:
Utah Geological Survey
and
Utah Engineering Experiment Station
University of Utah

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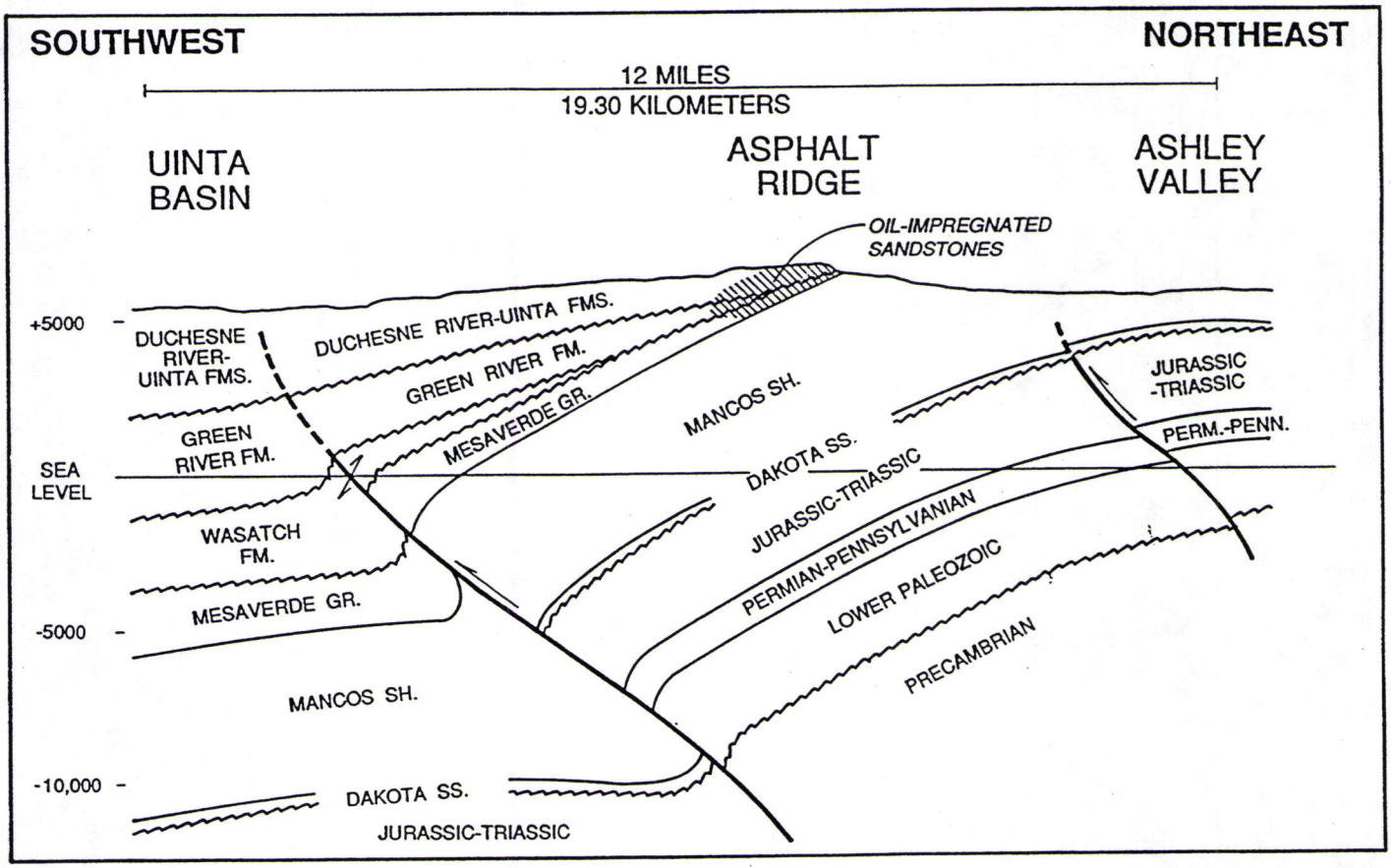

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ABSTRACT

Tar-sand, or oil-impregnated sandstone, deposits and occurrences of the Uinta Basin, Utah are summarized and presented. Twenty five tar-sand deposits/occurrences are reviewed with respect to geology, locations of bitumen-saturated outcrops, land ownership, physiography, bitumen-analyses, development histories, and other aspects. Background information on the physical setting and regional geology of the Uinta Basin is presented along with discussions of theories on the sources of the bitumen. Four areas--Asphalt Ridge, P.R. Spring, Hill Creek, and Sunnyside are presented as the principal areas containing most of the tar-sand resource. The Asphalt Ridge tar-sand deposit, located on the north flank of the Uinta Basin and enclosed in steeply dipping rocks of the Mesaverde Group (Cretaceous) and Duchesne River Formation (Eocene-Oligocene), is estimated to contain more than 1 billion barrels of oil. The P.R. Spring and Hill Creek deposits, located along the southeast margin of the basin and enclosed by gently dipping rocks of the Green River Formation (Eocene), are estimated to comprise a resource in excess of 4 billion barrels of oil. The Sunnyside deposit, located along the south margin of the basin enclosed by rocks of the Wasatch and Green River Formations (Eocene) is the largest of the deposits, estimated to contain more than 5 billion barrels of oil.

The remaining 21 areas discussed are scattered along the northern and southwestern margins of the basin. Along the northeastern side of the basin lies the Raven Ridge, Cow Wash, Rimrock, Spring Hollow, and Upper Kane Hollow deposits. The Chapita Wells and Pariette deposits, located in the central part of the basin are contained in rocks of the Uinta Formation (Eocene), but may be related to near-vertical faults and fractures. Deposits along the southwestern side of the Uinta Basin that may be genetically related to the Sunnyside deposit include Argyle Canyon, Minnie Maud Creek, Ninemile Canyon, and Willow Creek. The Whiterocks deposit, along the north basin margin is unique because it occurs in the Navajo Sandstone of Jurassic age. The Daniels Canyon deposit, located just outside of the western margin of the basin, is associated with fractures in Paleozoic rocks. The Thistle and Oil Hollow deposits, located at the extreme western end of the basin, are contained in oolitic limestone of the Paleocene Flagstaff Limestone and the Green River Formation, respectively.

Whiterocks

Location and Access

The Whiterocks deposit lies on the northern flank of the Uinta Basin, 27 miles (43.5 km) north of Roosevelt, Duchesne County, and 30 miles (48 km) northwest of Vernal, Uintah County (figure 25). The deposit is located near the mouth of Whiterocks Canyon, and is directly northwest of the Littlewater Hills deposit. The deposit is in sections 17-19, T.2N., R.1E., and section 24, T.2N., R.1W. (USM), Uintah County, and covers an area of about 400 acres. The deposit is found on the USGS Ice Cave Peak 7.5-minute quadrangle.

Access to the deposit is via various county roads either west from Vernal or north from Roosevelt toward the town of White Rocks. From White Rocks, there is a graded road which parallels the east side of Whiterocks River, crossing the deposit.

Physiography and Land-Use

The deposit is found within the marginal benches subsection of the Uinta Mountains physiographic province. Bitumen-saturated sandstone crops out on the east and west sides of Whiterocks Canyon and is probably continuous beneath valley alluvium (figure 57). The main part of the deposit lies at an elevation of 7,200 feet (2,195 m). The valley area is mostly private land surrounded on three sides by the Ashley National Forest. To the south lies the Uinta and Ouray Reservation. The Whiterocks River has eroded through the deposit, forming a flood-plain as wide as 3,500 feet (1,158 m). The Whiterocks River is a major tributary to the Duchesne and Green Rivers. The bitumen-saturated and other formations form steep cliffs at the mouth of Whiterocks Canyon. The west wall rises about 300 feet (91 m) and the east wall rises about 500 feet (152 m) above the valley (Peterson, 1985).

Geologic Setting

Exposed strata consists primarily of steep, southeast-dipping Triassic and Jurassic rocks (figure 58). At the mouth of Whiterocks Canyon, the Wasatch Formation (Paleocene-Eocene) lies unconformably upon south-dipping rocks of the Mancos Shale and Mesaverde Group (Cretaceous). The Navajo Sandstone (Jurassic) lies unconformably above the Chinle Formation (Triassic) and unconformably below the Carmel Formation (Jurassic). Other formations exposed in Whiterocks Canyon include Precambrian, Cambrian, Mississippian, Pennsylvanian, Permian, Triassic, and Jurassic age rocks.

The Navajo Sandstone, which is also called the Nugget Sandstone in northeastern Utah, is bitumen-saturated in and around Whiterocks Canyon (figure 58). The Navajo is divided into two units; a thin-bedded lower unit, and a highly cross-stratified upper unit (Uyger and Picard, 1985). The Navajo is mostly of eolian origin, deposited in dune fields and interdune environments (Picard, 1975; Uygur, 1983). The enclosing Chinle and the Carmel Formations are comprised mainly of impervious shales that may have acted to seal in oil migrating into the Navajo.

The deposit is associated with the crest of a steep, south-plunging anticlinal nose (Whiterocks anticline) that subparallels the Whiterocks River. The influence of this structure on bitumen saturation is unknown.

Covington (1963) suggested several theories about the origin of the oil. He favored a Pennsylvanian age for the oil migrating from the Weber Sandstone. He also suggested the Green River Formation (Eocene) as a possible source due to similarities in chemical analyses. Sulfur isotopes (Mauger and others, 1973) support this theory.

The bitumen-saturated zone occurs almost entirely within the Navajo Sandstone, and is about 900 feet (274 m) thick. The deposit strikes N65°E for about 1.5 miles (2.4 km). The outcrop is covered on both sides by the Duchesne River Formation (Eocene-Oligocene).

The Navajo is a consolidated, fine-grained, and well-sorted subarkose. Poorly sorted zones of sandstone with a bimodal grain-size distribution are also present. Mineralogically, the Navajo Sandstone is mature and relatively uniform, with varying amounts of clays, iron oxides, and carbonate cements. Shale, siltstone, and calcareous zones are uncommon. Fracturing is common, although orientation is variable. The degree of bitumen saturation is dependent on permeability and is, therefore, not uniform; barren zones are adjacent to rich zones.

Numerous resource estimates have been calculated for the Whiterocks deposit. Severy (1943) estimated resources of 9.52 million barrels based on outcrop mapping. Based upon the results of 11 core-holes, Shirley (1961)

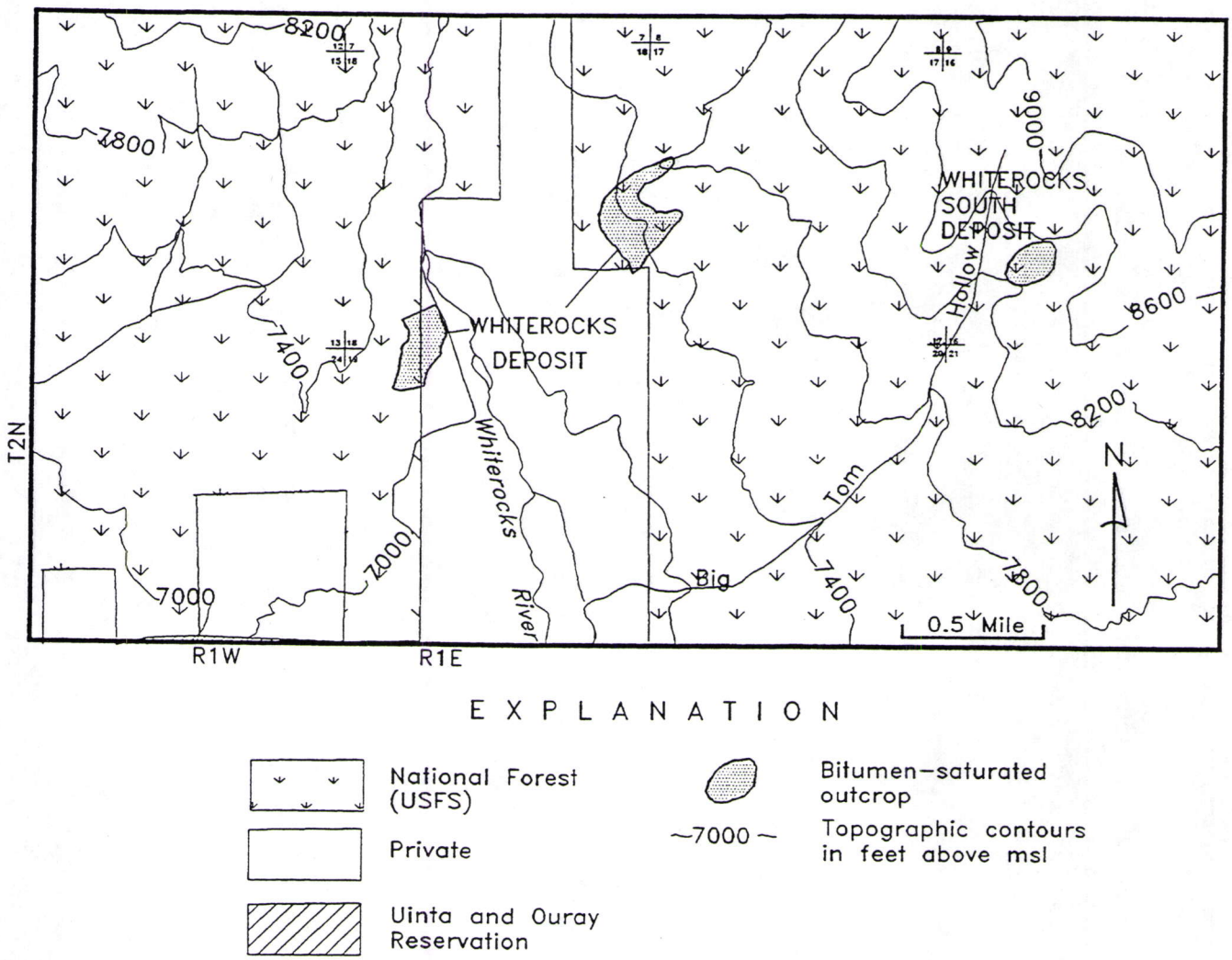
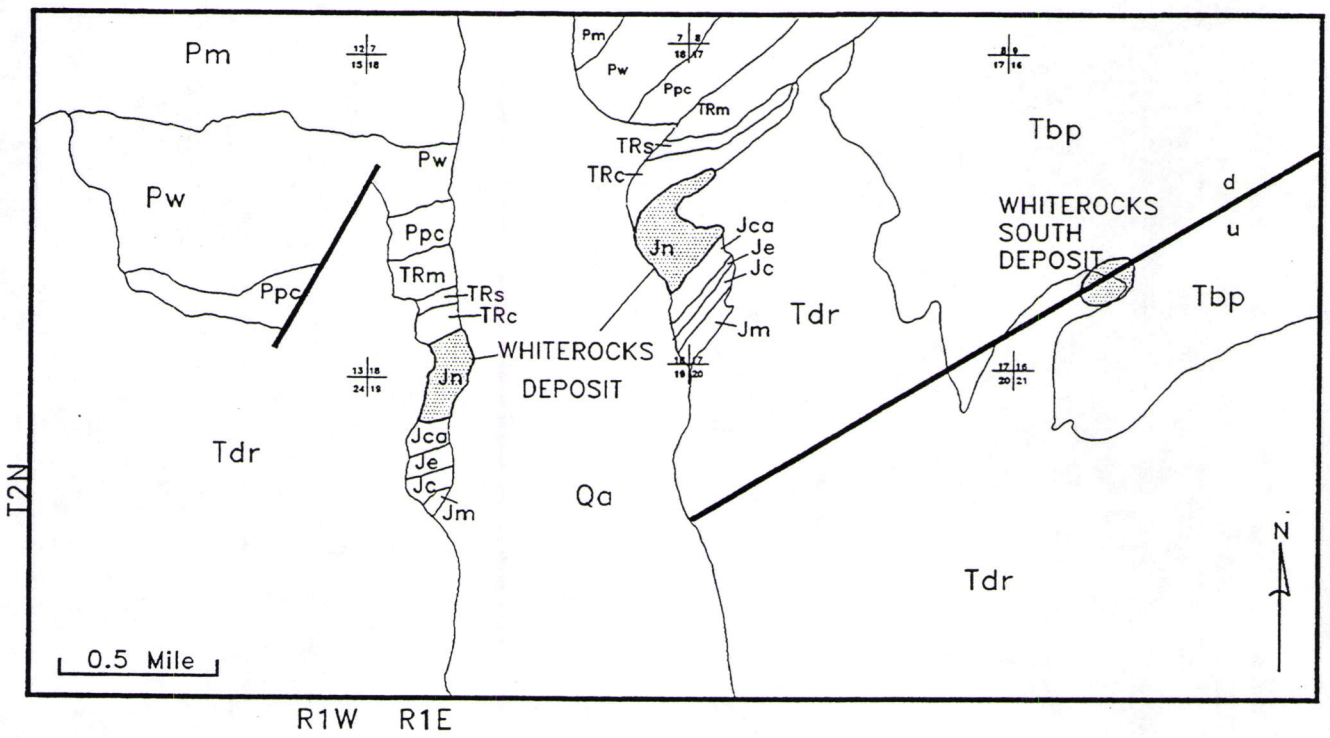


Figure 57. *Land-ownership map of the Whiterocks and Whiterocks South tar-sand area.*



EXPLANATION

Qa	Alluvium	TRc	Chinle Formation
Tbp	Browns Park Formation	TRs	Shinarump Formation
Tdr	Duchesne River Formation	TRm	Moenkopi Formation
Jm	Morrison Formation	Ppc	Park City Formation
Jc	Curtis Formation	Pw	Weber Sandstone
Je	Entrada Formation	Pm	Morgan Formation
Jca	Carmel Formation		
Jn	Navajo Formation		

Bitumen–saturated outcrop
Geologic contact
Fault

Figure 58. *General geology of the Whiterocks and Whiterocks South tar-sand areas (after Covington, 1964; tar-sand outcrops from K. Clem, unpublished data).*

calculated total resources of 105 million barrels. Of this total, Shirley classified 57 million barrels as proven reserves and 27 million barrels as probable resources. Covington (1963), using existing core-hole data and results of surface mapping, estimated approximately 50 million barrels. Lewin and Associates (1984) reported a measured resource of 60 million barrels in-place for 200 acres, with speculative resources of another 60 million barrels on 200 acres, calculating 600 feet (183 m) of saturation. Peterson (1985) suggested that the deposit contains more than 100 million barrels of oil in-place. Campbell (1975a) calculated 37.3 million barrels of oil-in-place, assuming 182 acres with 500 vertical feet (152 m) of saturation. Ritzma (1979) classified the deposit as "very large," with 65 to 125 million barrels of oil in-place. From this he categorized 50 million barrels as measured, 15 million barrels as indicated, and the remainder inferred.

It is interesting to note that the lower portion of the Duchesne River Formation, which overlies the eastern extent of the deposit, contains saturated pebbles of Navajo Sandstone. Bitumen occurs in the Duchesne River Formation, however, only along the contact with the Navajo Sandstone. This might indicate that oil migration was prior to deposition of the Duchesne River Formation.

Bitumen Analyses

Wood and Ritzma (1972) reported standard analyses of bitumen samples from the deposit, and Mauger and others (1973) presented data for sulfur isotopes (table 2). Sample 68-10E was collected from the Navajo Sandstone prospect pit, located in the SW¼NE¼SE¼ section 18, T.2N., R.2E. The WR-1, WR-2, and WR-3 samples are from the Navajo, located at T.2N., R.1E.

Development History

Peterson (1985) reported the results of exploratory drilling and presented a brief synopsis of development activities. Tar-sand exploration and development at Whiterocks until the 1940s was limited to small mining operations in pits and adits. In 1957 and 1958, three exploratory wells were drilled along the trend of the deposit in an effort to find liquid crude-oil. Two extraction plants were constructed in the early 1960s and used hot water and solvents in their processes. Also in the early 1960s, White Rocks Oil Properties of Salt Lake City drilled 11 core holes in the deposit; nine of these drill holes reportedly penetrated the entire bitumen-saturated interval. Western Industries of Las Vegas, Nevada, opened a strip-mine and built a pilot plant along the east side of the Whiterocks River apparently in the late 1960s. Major Oil Company, in the early 1970s, opened a strip-mine and built a pilot plant on the west side of the Whiterocks River (Peterson, 1985). Although other companies conducted exploratory work in the early 1980s, no other processing facilities were constructed. The quarry on the west side of the Whiterocks River is now being mined by Duchesne county for highway paving use.

Whiterocks South

Location and Access

The Whiterocks South deposit lies on the northern flank of the Uinta Basin in the SW¼ section 16, T.2N., R.1E. (USM), Uintah County (figure 25). Access to the deposit is by various county roads either west from Vernal or north from Roosevelt to the town of Whiterocks. From Whiterocks, a graded road parallels the mountain front, on the east side of Whiterocks Canyon. Located about one mile (1.6 km) east of the Whiterocks deposit, the Whiterocks South deposit can only be reached by fire-control roads and hiking trails.

To date, no analytical data are available and no exploratory work has been done for the Whiterocks South tar-sand occurrence.

Physiography and Land-Use

The Whiterocks South deposits consists of one small, bitumen-saturated outcrop near the head of a small side-canyon (Big Tom Hollow) of Whiterocks Canyon, and lies entirely within Ashley National Forest. The occurrence is located in mountainous terrain at an elevation of about 8,500 feet (2,591 m), is mostly obscured by brush, and occupies an area of less than one square mile (figure 57).

Geologic Setting

The Whiterocks South deposit (figure 58) is geologically similar to the Littlewater Hills deposit located about three miles (4.8 km) to the southeast. The deposit is located on the north flank of the Uinta Basin in the belt of south-dipping beds that marks the basin margin in this area. One mile (1.6 km) east of this deposit, the Navajo Sandstone (Jurassic) dips 65 degrees south.

The Duchesne River Formation (Eocene-Oligocene) rests unconformable upon the buried Mesozoic section and is overlain by the Browns Park Formation (Miocene). The Duchesne River Formation is composed of diverse fluvial sedimentary rocks. These fluvial deposits consist of heterogeneous, laterally discontinuous sandstone lenses with varying amounts of conglomerate and poorly stratified, fine-grained rocks (Anderson and Picard, 1972). Along south-facing slopes, dense brush obscures exposures of the upper Duchesne River contact.

Bitumen saturates less than 15 feet (5 m) of the basal part of the Duchesne River Formation (Ball Associates, Ltd, 1964). A small northeast-trending fault in the area suggests a possible relationship to the bitumen occurrence. Ball Associates, Ltd. (1964) classified this deposit as a "minor" occurrence with no economic significance.